AMENDMENTS TO THE CLAIMS

Claims 1-19 (Canceled)

20. (New) A method of interactively analyzing and optimizing a computer generated model of a design of a vehicle, said method comprising the steps of:

preparing an analytical reliability and robustness parameter diagram using a computer system, wherein said reliability and robustness parameter diagram identifies a parameter within the computer generated model of the vehicle design to be analyzed and a set of design points of corresponding characteristics;

selecting a portion of a design space from the computer generated model of the vehicle design to approximate an associated performance surface and randomly selecting sample points within the selected portion of the design space;

performing a computer-based engineering simulation using the randomly selected sample points as an input value, to determine a corresponding output value;

determining a residual output value using the randomly selected sample points, wherein the residual output value is determined by approximating a performance surface response for the randomly selected sample points;

optimizing the approximated performance surface response within a predetermined degree of accuracy;

determining a performance of the design using the optimized response that approximates the performance surface;

evaluating the performance of the design by the user to determine if the design meets a predetermined criteria;

adopting the design as a final design if the performance meets the predetermined criteria, otherwise continuing to optimize the overall design to be robust using a relationship between a value of the performance and a probability of occurrence, until the design meets the predetermined criteria; and

using the design for the vehicle.

21. (New) The method as set forth in claim 20, wherein said step of identifying a parameter diagram further includes the steps of:

describing the identified parameter;

specifying a range for the identified parameter;

specifying a variation for the identified parameter;

specifying an uncontrolled variable for the identified parameter;

specifying a design goal for the identified parameter;

specifying an assessment of a reliability of the identified parameter;

specifying an acceptable variance for the identified parameter;

describing a system input signal applied to the design model; and

specifying an expected system response to the system input signal.

22. (New) The method as set forth in claim 20 wherein said step of selecting a design space further includes the steps of:

randomly sampling the design space using an optimal Latin hypercube sampling technique, which further including the steps of:

defining a Tabu set and initially setting the Tabu set to empty;

performing an entropy analysis on a random sample of design points and placing a design point with a best solution into an m+ set, wherein the best solution is the solution having the lowest entropy;

performing a pairwise substitution using the random sample of design points;

performing an entropy analysis on each pairwise substitution, and comparing each pairwise substitution entropy with the entropy value for the best solution stored within the set m+;

placing each randomly sampled design point having an entropy below a predetermined threshold in the "T" set; and

determining whether the design points in the "T" set represent a best solution, and returning to the step of performing the pairwise substitution if they do not represent the best solution, and using the design points within the "T" set to approximate a performance surface if they do represent the best solution.

23. (New) The method as set forth in claim 20 wherein said step of performing a simulation by the computer system further includes the steps of:

performing a computer-aided engineering analysis on the model to determine an actual output response.

24. (New) The method as set forth in claim 20 wherein said step of determining a residual output value further includes the steps of:

applying a Multivariate Adaptive Regressive Spline (MARS) technique to the randomly selected design points to determine a MARS output value, and the residual value is a difference

between the output value obtained from the computer-based engineering simulation and the MARS output value;

using the residual value and a Kriging algorithm to determine a Kriging output value for the randomly selected design points;

summing together the residual value and Kriging output value for the randomly selected design points to approximate a performance surface; and

comparing the simulated performance surface to the calculated performance surface to validate the approximated performance surface, and storing the validated MARS residual value and Kriging output value in the processor.

25. (New) The method as set forth in claim 20 wherein said step of optimizing the set of design points further includes the steps of:

selecting the parameter representing the randomly selected sample points and a corresponding output value;

evaluating a correlation of the parameter to the approximated performance surface, wherein the correlation is an amount of non-linearity of the parameter;

identifying a parameter having a high level of non-linearity and adding the additional design points for the identified parameter to the randomly selected sample points and the corresponding output value;

determining a modeling error by comparing a difference between the approximated output value and the actual output value; and

comparing the modeling error with a predetermined threshold modeling error, and using the approximated performance surface if the modeling error is below the predetermined

threshold, otherwise combining the additional sample points with the randomly selected sample points and returning to the step of selecting the parameter if the modeling error is above the predetermined threshold.

26. (New) The method as set forth in claim 20 wherein said step of determining the performance of the design further includes the steps of:

selecting a design parameter that approximates the performance surface; and

using a successive linear approximation method to approximate the performance surface.

27. (New) The method as set forth in claim 20 wherein said step of continuing to optimize the overall design to be robust further includes the steps of creating a probability distribution function for each output value.

28. (New) The method as set forth in claim 27 further including the steps of:

calculating a distance between a first percent value and a second percent value to determine a robustness of each approximated output value, wherein there is a direct correlation between variance and robustness; and

identifying the output value and corresponding parameter with the smaller distance as robust.

29. (New) The method as set forth in claim 27 further including the step of using a saddle point method with second order approximation to determine a most probable point within the probability distribution function.

30. (New) The method as set forth in claim 27 further includes the steps of:

normalizing the performance space, so that the nominal value is at the origin and the most probable point is located on a boundary and has a smaller distance to the origin then other points on the boundary; and

determining an influence of the parameter from a sensitivity around the most probable point, wherein the influence is a summation of a sensitivity and a variability of the parameter.

33. (New) The method as set forth in claim 20 further including the step of providing the user with the most influential variables for each design point.

34. (New) A method of interactively analyzing and optimizing a computer generated model of a design of a vehicle, said method comprising the steps of:

preparing an analytical reliability and robustness parameter diagram using a computer system, wherein said reliability and robustness parameter diagram identifies a parameter within the computer generated model of the vehicle design to be analyzed and a set of design points of corresponding characteristics;

selecting a portion of a design space from the computer generated model of the vehicle design to approximate an associated performance surface and randomly selecting sample points within the selected portion of the design space;

performing a computer-aided engineering analysis on the model using the randomly selected sample points as an input value, to determine a corresponding output value to determine an actual output response;

determining a residual output value using the randomly selected sample points, wherein the residual output value is determined by approximating a performance surface response for the randomly selected sample points;

optimizing the approximated performance surface response within a predetermined degree of accuracy;

determining a performance of the design using the optimized response that approximates the performance surface by selecting a design parameter that approximates the performance surface and using a successive linear approximation method to approximate the performance surface;

evaluating the performance of the design by the user to determine if the design meets a predetermined criteria ;

adopting the design as a final design if the performance meets the predetermined criteria, otherwise continuing to optimize the overall design to be robust using a relationship between a value of the performance and a probability of occurrence by creating a probability distribution function for each output value, until the design meets the predetermined criteria ;

providing the user with the most influential variables for each design point; and

using the final design in the vehicle.

35. (New) The method as set forth in claim 34, wherein said step of identifying a parameter diagram further includes the steps of:

describing the identified parameter;

specifying a range for the identified parameter;

specifying a variation for the identified parameter;

specifying an uncontrolled variable for the identified parameter;

specifying a design goal for the identified parameter;

specifying an assessment of a reliability of the identified parameter;

specifying an acceptable variance for the identified parameter;

describing a system input signal applied to the design model; and

specifying an expected system response to the system input signal.

36. (New) The method as set forth in claim 34 wherein said step of selecting a design space further includes the steps of:

randomly sampling the design space using an optimal Latin hypercube sampling technique, which further including the steps of:

defining a Tabu set and initially setting the Tabu set to empty;

performing an entropy analysis on a random sample of design points and placing a design point with a best solution into an m+ set, wherein the best solution is the solution having the lowest entropy;

performing a pairwise substitution using the random sample of design points;

performing an entropy analysis on each pairwise substitution, and comparing each pairwise substitution entropy with the entropy value for the best solution stored within the set m+;

placing each randomly sampled design point having an entropy below a predetermined threshold in the "T" set; and

determining whether the design points in the "T" set represent a best solution, and returning to the step of performing the pairwise substitution if they do not represent the best

solution, and using the design points within the "T" set to approximate a performance surface if they do represent the best solution.

37. (New) The method as set forth in claim 36 wherein said step of determining a residual output value further includes the steps of:

applying a Multivariate Adaptive Regressive Spline (MARS) technique to the randomly selected design points to determine a MARS output value, and the residual value is a difference between the output value obtained from the computer-based engineering simulation and the MARS output value;

using the residual value and a Kriging algorithm to determine a Kriging output value for the randomly selected design points;

summing together the residual value and Kriging output value for the randomly selected design points to approximate a performance surface; and

comparing the simulated performance surface to the calculated performance surface to validate the approximated performance surface, and storing the validated MARS residual value and Kriging output value in the processor.

38. (New) The method as set forth in claim 37 wherein said step of optimizing the set of design points further includes the steps of:

selecting the parameter representing the randomly selected sample points and a corresponding output value;

evaluating a correlation of the parameter to the approximated performance surface, wherein the correlation is an amount of non-linearity of the parameter;

identifying a parameter having a high level of non-linearity and adding the additional design points for the identified parameter to the randomly selected sample points and the corresponding output value;

determining a modeling error by comparing a difference between the approximated output value and the actual output value; and

comparing the modeling error with a predetermined threshold modeling error, and using the approximated performance surface if the modeling error is below the predetermined threshold, otherwise combining the additional sample points with the randomly selected sample points and returning to the step of selecting the parameter if the modeling error is above the predetermined threshold.

39. (New) The method as set forth in claim 34 wherein said step of creating a probability distribution function for each output value further includes the steps of:

calculating a distance between a first percent value and a second percent value to determine a robustness of each approximated output value, wherein there is a direct correlation between variance and robustness; and

identifying the output value and corresponding parameter with the smaller distance as robust.

40. (New) The method as set forth in claim 39 further including the step of using a saddle point method with second order approximation to determine a most probable point within the probability distribution function.

41. (New) The method as set forth in claim 39 further includes the steps of:

normalizing the performance space, so that the nominal value is at the origin and the most probable point is located on a boundary and has a smaller distance to the origin then other points on the boundary; and

determining an influence of the parameter from a sensitivity around the most probable point, wherein the influence is a summation of a sensitivity and a variability of the parameter.

42. A system of interactively analyzing and optimizing a computer generated model of a design of a vehicle comprising:

a computer system, wherein said computer system includes a processor having a memory, an input means operatively in communication with said processor and a display means operatively in communication with said processor;

a computer aided design model of a vehicle that is stored in a database and operatively communicated to said processor;

a computer aided engineering analysis software program that is operatively in communication with said processor;

an analytical reliability and robustness parameter diagram stored in the memory of said computer system, wherein said reliability and robustness parameter diagram identifies a parameter within the computer aided design model of the vehicle and a set of design points of corresponding characteristics; and

a vehicle model analysis and optimization software programs stored in the memory of said computer system, where said analysis and optimization software program selects a portion of a design space from the computer generated model of the vehicle design to approximate an

associated performance surface and randomly selects sample points within the selected portion of the design space, performs a computer-based engineering simulation using the randomly selected sample points as an input value, to determine a corresponding output value, determines a residual output value using the randomly selected sample points, wherein the residual output value is determined by approximating a performance surface response for the randomly selected sample points, optimizes the approximated performance surface response within a predetermined degree of accuracy, determines a performance of the design using the optimized response that approximates the performance surface, evaluates the performance of the design by the user to determine if the design meets a predetermined criteria, adopts the design as a final design if the performance meets the predetermined criteria, otherwise continues to optimize the overall design to be robust using a relationship between a value of the performance and a probability of occurrence, until the design meets the predetermined criteria and uses the design in the design of the vehicle.